EG&G Idaho

"Providing research and development services to the government"

INTEROFFICE CORRESPONDENCE

Date: July 30, 1992

To: Jerry R. Zimmerle, MS 1545

From: Robert L. Nitschke, MS 3960

Subject: Sr-90 DISCHARGE CALCULATION - RLN-51-92 Bob

Reference: R. A. Nitschke letter to J. R. Zimmerle, RLN-49-92, Same Subject, July 23, 1992

I received a request from Dan Harelson, DOE-ID, to provide additional calculational detail to support the referenced letter. The step by step detailed calculations associated with TAN Interim Action Sr-90 discharges are provided as an attachment to this letter.

If you have any questions or need further information, please call.

td

Attachment:
As Stated

cc: Central Files, MS 1651
R. L. Nitschke File

The methodology used to determine if releases of Sr-90 from the TAN Interim Action Facility at the DOE Derived Concentration Value would be protective of human health involved five steps. The five steps were:

1) Calculate amount of contaminated soil.

2) Calculate amount of Sr-90 activity discharged.

3) Calculate Sr-90 soil concentrations at end of two years and at 30 years (occupational & residential scenario).

4) Solve risk based preliminary remediation goals in accordance with Part B of EPA's Human Health Evaluation Manual.

5) Compare preliminary remediation goals with calculated Sr-90 soil concentrations.

Details of these five steps follow:

1) Calculate amount of contaminated soil. Assume Sr-90 distributed uniformly over 5 acres and within .3m of surface.

Therefore,

Amount of Contaminated Soil =

$$(5\ acres)\left(\frac{4047m^2}{acre}\right)(.3m)\left(\frac{1.5g}{cc}\right)\left(\frac{1x10^6cc}{m^3}\right) = 9.1x10^9\ grams$$

2) Calculate amount of Sr-90 activity discharged. Assume 50 gpm continuous discharge for two years @ discharge concentration of

$\frac{1000\ pCi}{l}$ (DOE DCG level)

Therefore,

Amount of Sr-90 discharged =

$$\left(\frac{50\ gal}{\min}\right)\left(\frac{60\ \min}{hr}\right)\left(\frac{8760 hr}{year}\right)(2 years)\left(\frac{3.785 l}{gal}\right)\left(\frac{1000 pCi}{l}\right) =$$

$$1.99 x 10^{11}\ pCi = .2\ Ci$$

3) Calculate Sr-90 soil concentration at end of two years and at 30 years (occupational and residential scenario).

Assume no decay during two years of discharge & uniform distribution.

Therefore,

Occupational Sr-90 soil concentration =

$$\frac{(2 x 10^{11}\ pCi)}{9.1 x 10^{9}\ grams} = 21.8\ pCi/g$$

for residential at 30 years (essentially one half-life)

$$= \frac{(2 x 10^{11}\ pCi)\left(e^{-\left(\frac{ln2}{29.1}\right)(30)}\right)}{9.1 X 10^{9}\ grams} = 10.8 \frac{pCi}{g}$$

where

Sr-90 half-life = 29.1 years

4) Solve risk based preliminary remediation goals in accordance with Part B of EPA's Human Health Evaluation Manual. Use Chapter 4 of cited document entitled "Risk-Based PRGs for Radioactive Contaminants." More specifically, for occupational scenario use Equation 13 entitled "Radionuclide PRGs Commercial/Industrial Soil-Carcinogenic Effects" modified in two ways. First, Sr-90 is not volatile so volatilization term is deleted and secondly, since Sr-90 and its daughter Y-90 are not gamma emitters, the external exposure term is deleted, so

Risk based Sr-90 PRG in soil =

$$\frac{TR}{ED \times SF_o \times 10^{-3} \times EF \times IR_{soil} + ED \times SF_i \times 10^{3} \times EF \times IR_{air} \times \frac{1}{PEF}}$$

where,

TR = target risk = $1x10^{-6}$
ED = exposure duration = 25 year
SF_o = ingestion slope factor = 3.6 E-11 (Sr-90+D)
EF = exposure frequency = 250 days/year
IR_{soil} = daily soil ingestion rate = 50 mg/day
SF_i = inhalation soil factor = 6.2 E-11 (Sr-90+D)
IR_{air} = workday inhalation rate = 20 m^3/day
PEF = particulate emission factor = $4.09x10^8$

where,

equation 9 entitled "Particle Emission Factor" is used as follows:

$$PEF = \frac{LS \times V \times DH \times 3600}{A} \times \frac{1000}{0.036 \times (1-G) \times \left(\frac{U_m}{U_t}\right)^3 \times F(x)}$$

where,

LS = width of contaminated area = 142m
V = windspeed in mixing zone = 3.4m (from Track 1)
DH = diffusion height = 2m
A = area of contamination = 20,235m^2
G = fraction of vegetative cover = .25 (from Track 1)
U_m = mean annual wind speed = 3.4 m/s (from Track 1)
U_t = threshold value of wind speed = 8.2 m/s (from Track 1)
F(x) = function dependent on U_m/U_t = .22 (from Track 1)

therefore,

Occupational
Risk-based Sr-90
PRG in soil = 89.6 pCi/g

In a similar manner,

The residential risk based Sr-90 PRG in soil for ingestion & inhalation is calculated using equation 11 entitled, "Radionuclide PRGs: Residential Soil - Carcinogenic Effects" modified in two ways. First, since Sr-90 and its daughter Y-90 are not gamma emitters, the external exposure term is deleted and secondly an inhalation term is added.

Therefore,

Risk based Sr-90 PRG in soil =

$$\frac{TR}{(SF_o \times 10^{-3} \times EF \times IF_{\frac{soil}{adj}}) + ED \times SF_i \times 10^3 \times EF \times IR_{air} \times \frac{1}{PEF}}$$

where,

TR	=	Target Risk = $1x10^{-6}$
EF	=	Exposure Frequency = 350 days/year
$IF_{soil/adj}$	=	age-adjusted soil ingestion factor = 3600 mg-yr/day
ED	=	exposure duration = 30 years
SF_o	=	ingestion slope factor = 3.6E-11 (Sr-90+D)
SF_i	=	inhalation slope factor = 6.2E-11 (Sr-90+D)
IR_{air}	=	inhalation rate = $20m^3$/day
PEF	=	Particulate Emission Factor = $4.09x10^9$ m^3kg

Therefore,

Residential Risk-Based Sr-90 PRG in Soil = 21.4 pCi/g

5) Compare preliminary remediation goals with calculated Sr-90 soil concentrations.

Scenario	Soil Concentration pCi/g	PRG for $1x10^{-6}$ risk pCi/g
Occupational	21.8	89.6
Residential	10.8	21.4